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**Prokaryotic Cells: What are they, and where did they come from?**

Pre-AP Biology, Ms. Ottolini, 2012-2013

1. **Outline Chapter 19, Section 1 in your textbook (Page 471) on a separate piece of paper.** This section discusses bacteria, a type of prokaryote.

A reminder of the chapter outlining directions for this class is given below:

* Use roman numerals for main headings (in blue font in your textbook – I, II, III, IV, V, VI, VII, VIII, IX, X, etc.)
* Use letters for subheadings (in green font in your textbook – A, B, C, D, E, etc.)
* Use regular numbers for details (1, 2, 3, 4, 5, etc.)…. Details include defining bolded vocabulary terms and providing main ideas for each section
* Answer all questions in the Section Assessment at the end of the section

1. **Complete the prokaryotic cell coloring directions given below:**

Bacteria are unicellular (ONE CELL!) and are covered with a thick outer cell wall. *Color and label* the cell wall PURPLE.

Just within the cell wall is the cell membrane. *Color* *and label* the cell membrane PINK.

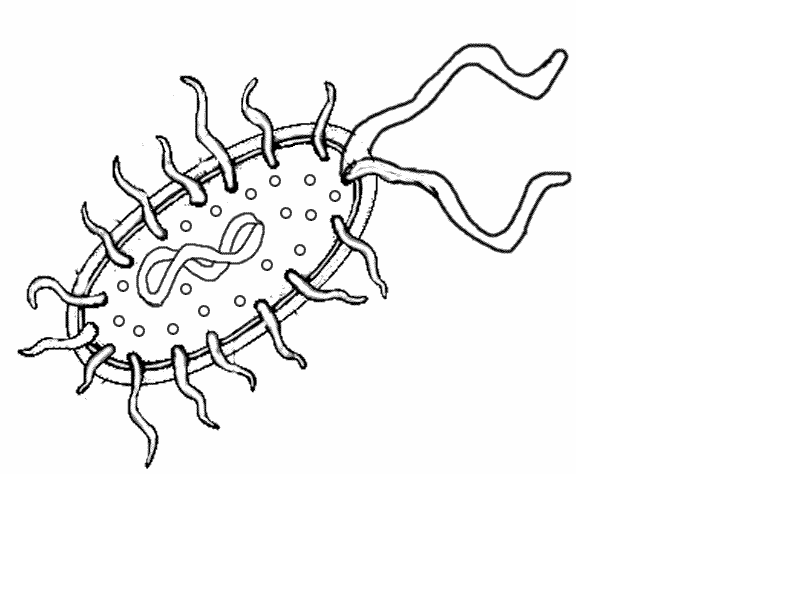
Along the surface of some bacteria are structures called pili (pilus-singular) that help bacteria adhere to surfaces. *Color and label* all the pili LIGHT GREEN.

Some bacteria are motile (can move). Many of these bacteria have long, whip like structures called flagella (flagellum-singular). *Color and label* the flagella DARK GREEN.

Since bacteria are prokaryotes, they do NOT have a nucleus. They do have a single strand of DNA (double helix), their chromosome, in the nucleoid region (center of the cell). This single strand of DNA contains all the instructions for making more bacterial cells. Locate the DNA and *color and label* it YELLOW.

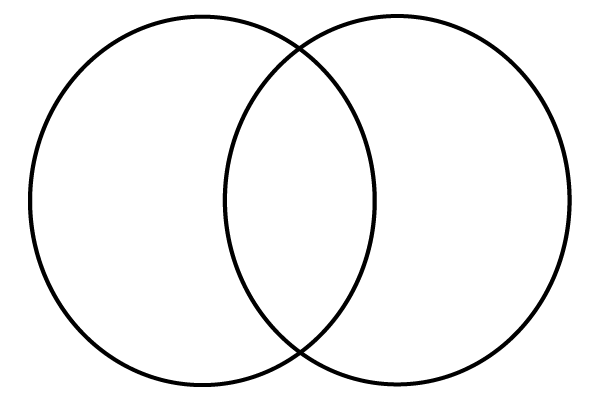
The inside of the bacterial cell is filled with cytoplasm. *Color and label* the cytoplasm LIGHT BLUE.

Sprinkled throughout the cytoplasm of the cell are small, round structures called ribosomes. Ribosomes make proteins for the cell. *Label and Color* all of the ribosomes RED.



1. **Create a Venn diagram comparing prokaryotic and eukaryotic cells.** Compare features like size, types of organisms where this cell type is found, organelles, etc. You must have at least four items in each portion of the diagram.

Prokaryotic Cell Both Eukaryotic Cell



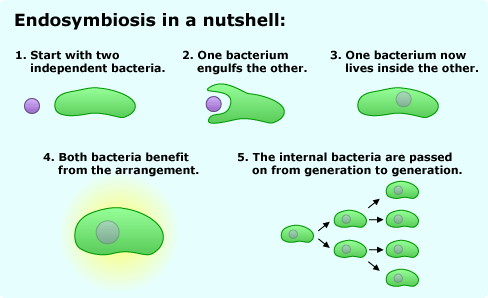
1. **Read through the article below, which describes how a eukaryotic cell developed from several prokaryotic cells.** You will then be asked to summarize the article.

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| |  |  | | --- | --- | | http://evolution.berkeley.edu/evolibrary/images/dot_clear.gif | 3 domains |   Living things have evolved into three large clusters of closely related organisms, called "domains": Archaea, Bacteria, and Eukaryota. Archaea and Bacteria are small, relatively simple cells surrounded by a membrane and a cell wall, with a circular strand of DNA containing their genes. They are called prokaryotes.  Virtually all the life we see each day — including plants and animals — belongs to the third domain, Eukaryota. Eukaryotic cells are more complex than prokaryotes, and the DNA is linear and found within a nucleus. Eukaryotic cells boast their own personal "power plants", called mitochondria. These tiny organelles in the cell not only produce chemical energy, but also hold the key to understanding the evolution of the eukaryotic cell. |

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| typical prokaryote and eukaryote cells |

The complex eukaryotic cell ushered in a whole new era for life on Earth, because these cells evolved into multicellular organisms. But how did the eukaryotic cell itself evolve? How did a humble bacterium make this evolutionary leap from a simple prokaryotic cell to a more complex eukaryotic cell? The answer seems to be symbiosis — in other words, teamwork.

Evidence supports the idea that eukaryotic cells are actually the descendents of separate prokaryotic cells that joined together in a symbiotic union. In fact, the mitochondrion itself seems to be the "great-great-great-great-great-great-great-great-great granddaughter" of a free-living bacterium that was engulfed by another cell, perhaps as a meal, and ended up staying as a sort of permanent houseguest. The host cell profited from the chemical energy the mitochondrion produced, and the mitochondrion benefited from the protected, nutrient-rich environment surrounding it. This kind of "internal" symbiosis — one organism taking up permanent residence inside another and eventually evolving into a single lineage — is called endosymbiosis.



**Evidence for endosymbiosis**

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| Biologist Lynn Margulis first made the case for endosymbiosis in the 1960s, but for many years other biologists were skeptical. Why should we think that a mitochondrion used to be a free-living organism in its own right? It turns out that many lines of evidence support this idea. Most important are the many striking similarities between prokaryotes (like bacteria) and mitochondria:   * **Membranes** — Mitochondria have their own cell membranes, just like a prokaryotic cell does. * **DNA** — Each mitochondrion has its own circular DNA genome, like a bacteria's genome, but much smaller. This DNA is passed from a mitochondrion to its offspring and is separate from the "host" cell's genome in the nucleus.   bacteria/mitochondria structural comparison   * **Reproduction** — Mitochondria multiply by pinching in half — the same process used by bacteria. Every new mitochondrion must be produced from a parent mitochondrion in this way; if a cell's mitochondria are removed, it can't build new ones from scratch.   bacteria/mitochondria reproduction  When you look at it this way, mitochondria really resemble tiny bacteria making their livings inside eukaryotic cells! Based on decades of accumulated evidence, the scientific community supports Margulis's ideas: endosymbiosis is the best explanation for the evolution of the eukaryotic cell.  the origins of mitochondria and chloroplastsWhat's more, the evidence for endosymbiosis applies not only to mitochondria, but to other cellular organelles as well. Chloroplasts are like tiny green factories within plant cells that help convert energy from sunlight into sugars, and they have many similarities to mitochondria. The evidence suggests that these chloroplast organelles were also once free-living bacteria.  The endosymbiotic event that generated mitochondria must have happened early in the history of eukaryotes, because all eukaryotes have them. Then, later, a similar event brought chloroplasts into some eukaryotic cells, creating the lineage that led to plants.  Despite their many similarities, mitochondria (and chloroplasts) aren't free-living bacteria anymore. The first eukaryotic cell evolved more than a billion years ago. Since then, these organelles have become completely dependent on their host cells. For example, many of the key proteins needed by the mitochondrion are imported from the rest of the cell. Sometime during their long-standing relationship, the genes that code for these proteins were transferred from the mitochondrion to its host's genome. Scientists consider this mixing of genomes to be the irreversible step at which the two independent organisms become a single individual.  Flagellum, cilia, nucleusEndosymbiosis explains the origin of mitochondria and chloroplasts, but could it also explain other features of the eukaryotic cell? Maybe. Endosymbiotic origins have been suggested for many structures, including flagella (structures like the tail of a sperm), cilia (hair-like structures that help in locomotion), and even the nucleus — the cell's command center! However, scientists are still actively debating whether or not these structures evolved through endosymbiosis. The jury is out while more evidence is gathered. | |
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**Summary:** In two full paragraphs (five to seven sentences each), summarize the article you just read. In the first paragraph, describe the details of endosymbiosis in your own words. In the second paragraph, discuss the evidence that scientists have gathered to support the cell theory. Write your summary on the same sheet of paper as your chapter outline.